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BULLETIN  
OF THE  
TORREY BOTANICAL CLUB

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Studies in North American Peronosporales—II. Phytophthoreae  
and Rhysotoheceae

GUY WEST WILSON

The family *Peronosporaceae*, which includes all the genera of the order except *Albugo*, may be briefly characterized as follows:

Mycelium intercellular; conidiophores aerial, variously branched; conidia borne singly at the apex of the ultimate branchlets of the conidiophores, germinating by zoöspores or rarely by a germ-tube; oöspores globular, variously sculptured, germinating by a germ-tube.

Of the three well-defined tribes which constitute this family, the first two are discussed in this paper. It is usual to follow the older authors in considering the species embraced in the genera at present under discussion, as clearly distinguished from the remaining members of the family by the method of germination of the conidia, which in the *Phytophthoreae* and *Rhysotoheceae* is normally by zoöspores, while those of the *Peronosporaceae* germinate by means of a germ-tube. It is, however, well known that under certain conditions the conidia of these species do not throw out zoöspores, but produce one or more germ-tubes. This is probably due to conditions which cause the potential zoöspores, which are already formed within the conidium, to germinate before escaping from the conidial membrane.\* With this real or apparent intergradation of characters, it is desirable to have a more stable basis for grouping the genera within the family. Characters which are much more easily observed and subject to less important variation are afforded by the conidiophores, the habit of branching of which conforms to the method of conidial germination.

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\* See Hartig, Unters. Forstbot. Inst. München 1: pl. 3.

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Like many other plants, the *Peronosporaceae* do not lend themselves readily to characterization. The conidia vary greatly in size and often to a surprising extent in outline, and the conidiophores from their very nature are difficult of description. For this reason it appears desirable to add the heading "icones" under which as complete a list as practicable of illustrations in American works and the chief foreign ones is given for each species. A key to the genera is also given in which the three tribes are characterized and the genera under the first two included, the third tribe being reserved for future treatment.

A serious handicap in the treatment of the species of this family is the lack of information upon many points which are of taxonomic importance. While in America the present family has received more attention than almost any other group of *Phycomycetes*, a wide field for investigation is still open. The oöspores of many species are unknown, and even when known are of rare occurrence in herbaria; the germination of but few species has been studied in America, our knowledge on this point being frequently derived from European sources; the problems of oögenesis are practically untouched; but few inoculation experiments have been conducted to determine the range of hosts which a single species will affect. It is therefore apparent that a final, or even a reasonably satisfactory treatment of the group at the present time is impracticable.

In conclusion I wish to express my sincere appreciation of the courtesies shown me in my work, and especially to those botanists who have so kindly supplied me with material in addition to that which was available in preparing the previous paper of this series.

Conidiophores not clearly differentiated from the mycelium, scorpioid-cymosely branched; conidia germinating normally by zoöspores. PHYTOPHTHOREAE.

A single genus.

1. *Phytophthora*.

Conidiophores clearly differentiated from the mycelium.

Conidiophores monopodially branched, the branches usually arising at right angles to the main axis, successively shorter; conidia germinating normally by zoöspores. RHYSOTHECEAE.

Conidiophores with the main axis indurate above, the lateral branches reduced and basidium-like.

2. *Basidiophora*.

Conidiophores with the main axis not indurate above, the lateral branches developed normally.

Conidiophores fugaceous, stout, sparingly branched; oöspores permanently united to the walls of the oögone. 3. *Sclerospora*.

Conidiophores persistent, slender, usually freely branching ; oöspores free from the walls of the oögone.

Branches of the conidiophore apically obtuse. 4. *Rhysotheca*.

Branches of the conidiophore apically acute. 5. *Pseudoperonospora*.

Conidiophores dichotomously branched, the branches arising at right angles to the main axis, successively shorter ; conidia germinating by a germ-tube.

PERONOSPOREAE.

1. PHYTOPHTHORA de Bary, Jour. Roy. Agr. Soc.

England II. 12 : 240. 1876

Mycelium much-branched, hyaline ; conidiophores arising singly or in groups from the stomata, or breaking through the epidermis, branched or apparently simple, with irregular thickenings below the conidia, which are borne apically in a scorpioid cyme ; conidia oval, papillate ; zoöspores oval, biciliate, escaping by the rupture of the papilla ; oöspores intramycelial, the episporium more or less ridged.

Type species, *Peronospora infestans* Casp.

Herbarium material of the species of this genus is very unsatisfactory for study, as the conidiophores form a very dense covering to the host, and being quite flaccid and often very long they form at maturity a dense felt in which the individual conidiophores are effectively obscured. This is especially true of *P. infestans*, while some of the foreign species are not difficult to study.

**Key to the species**

Conidia usually only one, rarely two, borne at the apex of an aborted cyme ; conidiophore simple or branched below.

Host Fabaceae.

1. *P. Phaseoli*.

Host Araceae.

2. *P. Colocasiae*.

Conidia numerous in a simple or compound cyme.

Conidia sessile or long-stalked in a simple cyme.

Conidia small, about 35  $\mu$ .

3. *P. Nicotianae*.

Conidia large, 50 $\mu$ , or more.

4. *P. Cactorum*.

Conidia sessile in a compound cyme.

Host Solanaceae.

5. *P. infestans*.

Host Ranunculaceae.

6. *P. Thalictri*.

1. PHYTOPHTHORA PHASEOLI Thaxter, Bot. Gaz.

14 : 274. 1889

The present species differs rather markedly from the other American species of the genus in the method of branching of the conidiophores, but in other respects they are quite similar. The conidiophores are very long, simple, or more commonly branched

at the base, and bear a single apical conidium, below which are several swellings of the conidiophore which indicate the typical cymosely branched conidiophore upon which the majority of conidia have failed to develop. This species, first described by Dr. Thaxter, has attracted the attention of various mycologists, among them Dr. Clinton, who has recently published a very complete discussion of this destructive parasite of the lima bean.\* His article is accompanied by illustrations of the oöspores and a complete bibliography of the species.

ON FABACEAE :

*Phaseolus lunatus* L., Connecticut, *Clinton* (Fungi Columb. 1949), *Rorer* (Funghi Par. Piant. Colt. 351), *Thaxter* (Econ. Fungi 9, N. Am. Fungi 2707); Delaware, *Jackson* 1554.

TYPE LOCALITY: New Haven, Connecticut, on *Phaseolus lunatus* L.

DISTRIBUTION: Connecticut to Maryland. Also in European Russia.

ICONES: Rep. Conn. Agr. Exp. Sta. 1900: pl. 3. f. 29-37; 1905: pl. 20-22; Bull. N. J. Agr. Exp. Sta. 151: 19. f. 6.

2. PHYTOPHTHORA COLOCASIAE Racib. Parasit.

Algen u. Pilze Javas 1: 9. 1900

This species, which is very closely related to *P. Phaseoli*, is said, by its author, to be very abundant on the taro, *Colocasia antiquorum*, throughout Java, but apparently not damaging the host. The fungus is to be expected in other tropical countries in which the host is cultivated.

3. PHYTOPHTHORA NICOTIANAE Van Breda de Haan, Meded.

Lands Plant. 15: 41. 1896

The present species, which is illustrated and described in great detail by its author, is a serious tobacco pest in the East Indies and may appear elsewhere at any time.

4. PHYTOPHTHORA CACTORUM (Lebert & Cohn) Schröter,

in Cohn, Krypt. Fl. Schles. 3<sup>1</sup>: 274. 1886

*Peronospora Cactorum* Lebert & Cohn, Beitr. Biol. Pflanz. 1<sup>1</sup>: 56. 1870.

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\*Ann. Rep. Conn. Agr. Exp. Sta. 1905: 278-303. pl. 20-22. 1906.

*Phytophthora omnivora* de Bary, Bot. Zeit. **39**: 584, 619. *pl.* 5. *f.* 33-41. 1881.

This species has long been a scourge in Europe on account of its attacks upon seedlings and succulents, its hosts including representatives of fifteen families ranging from *Pinaceae* to *Scrophulariaceae*. Until quite recently this species was not reported from other countries, its first record from foreign quarters being in connection with a serious outbreak of a pod-rot of cacao in the island of Trinidad.\* Material was sent to Massee, who identified one of the fungi concerned as *Phytophthora omnivora* de Bary. His description† is of a popular nature and would apply equally well to any one of several groups of fungi, while his figures are unmistakably of a species of *Phytophthora* of the same type as the present one. The conidia are somewhat more elongate and attenuate than usual. This, taken with the habitat, suggests that the pod-rot of the cacao may be caused by a distinct but closely related species, but no definite statement can be made without first examining fresh material. Since the first report of the outbreak of the disease, it has been reported from various other localities in the West Indies, South America, Asia and Africa. The history, distribution and nature of the disease are fully discussed by Howard.‡ The species is also included by Freeman in his Minnesota Plant Diseases § as a pest in seed-beds.

5. PHYTOPHTHORA INFESTANS (Mont.) de Bary, Jour.  
Roy. Agr. Soc. England II. **12**: 240. 1876

*Botrytis infestans* Mont. Mém. Inst. France **1845**: 313. 1845.  
*Peronospora infestans* Casp. in Rabenh. Herb. Viv. Myc. I. 1879.  
1854.

As one of our worst plant diseases is caused by the present species its distribution is rather well worked out. While the fungus is not so prevalent, except in localities where the potato is cultivated in large commercial quantities, the range of both appears to be coextensive. It is, however, much more destructive in the

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\* Hart, Bull. Trinidad Bot. Gard. **3**: 167-169. Ja 1899.

† Kew Bull. Misc. Inf. **1899**: 1-6. *plate.* 1899.

‡ West Indian Bull. **2**: 190-211. 1901.

§ Page 382. 1905.

northern than in the southern states, as it requires a cool, moist atmosphere in which to develop to the best advantage. Besides the potato, which is its chief host, the fungus attacks numerous other species of the genus *Solanum* as well as members of various other genera of *Solanaceae*.

ON SOLANACEAE:

*Solanum tuberosum* L., Connecticut, *Clinton* (Fungi Columb. 1839); Illinois, *Burrill*, *Seymour* (N. Am. Fungi 2204); Iowa, *Blackwood*, *Buchanan*, *Holway*, *Pammel*; New York, *Ellis* (Fungi Carol. 5: 92), *Whetzel*; Tennessee, *Scribner* (Econ. Fungi 447); Vermont, *Jones*; Wisconsin, *Pammel*, *Trelease*.

*Lycopersicon Lycopersicon* (L.) Karst., Delaware, *Smith* (Fungi Columb. 2138); South Carolina, *Ravenel* (Myc. Univ. 926).

TYPE LOCALITY: France, on *Solanum tuberosum* L.

DISTRIBUTION: Eastern Canada to California and Florida. Also in South America, Europe, Asia, Africa, and Australia.

ICONES: Bot. Zeit. 5: pl. 6. f. 1-6; Bull. Bussey Inst. 1: 319. fig.; Bull. Ill. Lab. Nat. Hist. 1<sup>1</sup>: pl. 2. f. 8-10; Frank, Lehrb. Bot. 2: 114. f. 321; Rep. U. S. Dep. Agr. 1888: Veg. Path. pl. 1, 2; Rep. Maine Agr. Exp. Sta. 1889: 172. f. 1-10; Rep. Vt. Agr. Exp. Sta. 1890: 132. fig.; Rep. N. J. Board Agr. 17: pl. 4; v. Tubeuf, Pflanzenkrankheiten 142. f. 31; Bull. Calif. Agr. Exp. Sta. 175: f. 3, 6-8; Berlese, Icon. Fung. Phyc. pl. 8.

## 6. *Phytophthora Thalictri* Wilson & Davis

Hypophyllous, the infested area suborbicular or irregular in outline, appearing somewhat glaucous; epiphyllous discoloration very dark, almost black, sometimes with a distinct brownish margin; conidiophores fasciculate from the stomata, continuous, lax and somewhat flexuose, rather scattered on the infested area and not forming a dense felt,  $300-400 \times 5-7 \mu$ , bearing usually 1 or 2 branches, subconidial swellings narrowly conical, less than twice as thick as the branch; conidia elliptic, apically papillate,  $20-27 \times 13-17 \mu$ ; oöspores unknown.

Type collected by Dr. J. J. Davis, June 20, 1907, in Kenosha County, Wisconsin, on *Thalictrum purpurascens* L.

Distinguished from *P. infestans* by the more pronounced dis-

coloration of the infested area and the less disastrous effect on the host; the shorter and more slender conidiophores which form a sparse covering to the infested area instead of forming a dense felt as in the other American species, and which are more persistent than is common in the genus; the slightly smaller and more elongate conidia. The material collected by Dr. Davis was all on a single plant of the host which is rather common in that region. Specimens of the type collection are in the herbaria of Dr. Davis, of the New York Botanical Garden, and of the author.

2. BASIDIOPHORA Roze & Cornu, Ann. Sci. Nat. V.

II : 84. 1869

Mycelium much-branched; conidiophores clavate, the apex an enlarged indurate axis upon which short, simple, cylindric lateral branches are borne alternately; conidia ovate to globose-ovate, smooth, hyaline, apically papillate, breaking away with a portion of the branch attached; zoöspores biciliate, monoplanal; oöspores produced in the tissues of the host in company with the conidiophores; epispore yellowish-brown, more or less irregularly ridged.

Type species, *Basidiophora entospora* Roze & Cornu.

The species of this genus are easily recognized by the clavate conidiophore with its short cylindric fertile branches. The only approach to this type of branching among the other members of the tribe is in the monotypic Japanese genus *Kawakamia* Miyabe, which is described as having the conidiophores "simple or sometimes branched without any order, generally only once and that not from the base of the conidium, slender and provided generally at the tip with a short pedicel-cell, which is more slender than the conidiophore," which is "swollen at base, and gradually tapering toward the tip."\*

**Key to the species**

- |   |                            |
|---|----------------------------|
| Conidiophores tall, reaching 300 $\mu$ ; conidia ovate; oöspores with prominent ridges.             | 1. <i>B. entospora</i> .   |
| Conidiophores short, not over 100 $\mu$ ; conidia globose-ovate; oöspores with very obscure ridges. | 2. <i>B. Kellermanii</i> . |

1. BASIDIOPHORA ENTOSPORA Roze & Cornu, Ann.

Sci. Nat. V. II : 84. 1869

*Peronospora entospora* Berk. & Br. Grevillea I : 20. 1872.

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\* Bot. Mag. Tokyo 17 : (306). 1903.



*Peronospora simplex* Peck, Ann. Rep. N. Y. State Mus. Nat. Hist.

31:45. 1879.

*Plasmopara entospora* Schröt. in Cohn, Krypt. Fl. Schles. 3<sup>1</sup>: 237. 1886.

Hypophyllous, forming angular areas 1–8 mm. across, bounded by the veins of the leaf; conidiophores arising from the stomata, singly or in groups, hyaline,  $150\text{--}300 \times 8\text{--}20 \mu$ , apically much enlarged,  $17\text{--}25 \mu$ , lateral branches 5–20, about  $6\text{--}10 \times 2 \mu$ ; conidia ovate,  $20\text{--}36 \times 10\text{--}20 \mu$ ; oöspore light yellowish-brown,  $40\text{--}50 \mu$ ; episore conspicuously ridged.

ON CARDUACEAE:

*Aster Novae-Angliae* L., Indiana, Wilson; Wisconsin, Trelease (N. Am. Fungi 1405).

*Aster oblongifolius* Nutt., Nebraska, \*Bates (Fungi Columb. 1950).

*Erigeron philadelphicus* L., Louisiana, Langlois 1669.

*Erigeron ramosus* (Walt.) B. S. P., Illinois, Earle, Waite.

*Leptilon canadense* (L.) Britton, Missouri, \*Pammel.

*Solidago rigida* L., Illinois. \*Seymour (N. Am. Fungi 1405b, Fungi Europ. 3277).

Reported also from our limits on *Aster sagittifolius* Willd. and *Rudbeckia fulgida* Ait.

TYPE LOCALITY: France, on *Leptilon canadense* (L.) Britton.

DISTRIBUTION: New York to Wisconsin, Nebraska, Texas, and Alabama. Also in Europe and South America.

ICONES: Ann. Sci. Nat. V. 11: pl. 4; Rabenh. Krypt. Fl. ed. 2. 1<sup>1</sup>: 424. f. 68; Berlese, Icon. Fung. Phyc. pl. 7.

## 2. *Basidiophora Kellermanii* (Ellis & Halsted).

*Peronospora Kellermanii* Ellis & Halsted "*pro tem.*"; Ellis & Everh. N. Am. Fungi 2201. 1889. (Hyponym.)

*Plasmopara* sp. Swingle, Trans. Kan. Acad. Sci. 11: 74. 1889.

*Plasmopara Kellermanii* Swingle; Sacc. Syll. Fung. 9: 342. 1891.

Hypophyllous, forming angular discolored patches which often cover a large portion of the leaf; conidiophores arising from the stomata, singly or in groups, very short, hyaline,  $25\text{--}100 \times 8\text{--}10 \mu$ , apically much enlarged, about  $15\text{--}20 \mu$ ; lateral branches 4–7, short,  $5\text{--}8 \times 2 \mu$ ; conidia globose-ovate,  $20\text{--}22 \times 18\text{--}20 \mu$ ; oöspores yellowish-brown, obscurely ridged,  $30\text{--}40 \mu$ .

This species has an interesting history, and, while known for some years, it has never been fully described. That it is abundant in those localities where it occurs is evidenced not only by the quotation below, but by the additional fact that in three instances material has been collected in sufficient quantity for distribution in exsiccati. The original collection was distributed in North American Fungi 2201, where it received its first name. A description was drawn at the same time by Dr. Halsted, to whom the material was submitted for determination, but this is still unpublished. Swingle's note on the species forms the basis of the diagnosis in Saccardo's *Sylloge Fungorum* and is as follows:

"This species has not yet been published, but seems to be a *Plasmopara* allied to *P. entospora*, from which it differs in having shorter fasciculate conidiophores and almost sessile conidia, which are smaller than in some forms of *P. entospora*. It is a very abundant and curious species, as yet little understood."

In addition to these points of difference attention should be called to the more globular conidia, the darker oöspores with their less conspicuously ridged epispore, and the larger infested area with more pronounced discoloration of the host in the present species than in the former.

ON AMBROSIACEAE:

*Iva xanthiifolia* Nutt., Kansas, \**Bartholomew* (Fungi Columb. 1841), \**Kellerman* (N. Am. Fungi 2201); Nebraska, \**Pammel*, \**Sheldon*; North Dakota, \**Seaver*; South Dakota, \**Griffiths* (W. Am. Fungi 191); Wyoming, \**Pammel & Stanton*.

TYPE LOCALITY: Manhattan, Kan., on *Iva xanthiifolia* Nutt.

DISTRIBUTION: North Dakota and Wyoming to Kansas.

ICON: Freeman, Minn. Pl. Diseases 111. f. 45.

3. SCLEROSPORA Schröter; de Bary, Bot. Zeit.

39: 621. 1881

*Peronospora* § *Sclerospora* Schröter, Hedwigia 18: 86. 1879.

Mycelium much branched, with small vesicular haustoria; conidiophores erect, solitary or in groups of 2-3, fugaceous, low and stocky, sparsely branched, the branches also stocky; conidia elliptic or globose-elliptic, hyaline, smooth; oöspores intramycelial,

the epispore brown, irregularly wrinkled, permanently united to the persistent wall of the oögonium.

Type species, *Protomyces graminicola* Sacc.

#### Key to the species

Oöspore small, 26–36  $\mu$ ; epispore not pronouncedly opaque; host,

*Chaetochloa*.

1. *S. graminicola*.

Oöspore large, 28–45  $\mu$ ; epispore very opaque; host, *Chloris*.

2. *S. Farlowii*.

1. SCLEROSPORA GRAMINICOLA (Sacc.) Schröter, in  
Cohn, Krypt. Fl. Schles. 3<sup>1</sup>: 236. 1886

*Protomyces graminicola* Sacc. Nuovo Giorn. Bot. Ital. 8: 172.  
1876.

*Peronospora graminicola* Schröter, in Zopf & Sydow, Myc. March.  
9. 1881.

*Peronospora graminicola Setariae-italicæ* Traverso, Bull. Soc. Bot.  
Ital. 1902: 168. f. 1–3. 1902.

Infesting leaves and inflorescence, causing marked distortion of the latter and, in the case of oöspores, the rapid disintegration of the former; conidiophores  $100 \times 10\text{--}12 \mu$ ; conidia  $20 \times 15\text{--}18 \mu$ ; oögone-wall thick,  $4\text{--}12 \mu$ , at maturity  $30\text{--}60 \mu$  diam., reddish-brown; oöspore pale-brown,  $26\text{--}36 \mu$ .

The conidiophores of this species are very stout and quite unlike those of any other American species of the order. Their very ephemeral character has caused them to be overlooked by collectors, while the reddish-brown color given to the leaves by the oöspores renders them rather conspicuous objects. As a result herbarium material of this species is rich in oöspores while the conidia are rare. The variety on *Chaetochloa italica* is described as having much larger oöspores than does the typical form, but an examination of American as well as authentic foreign material upon this host failed to show any constant or appreciable difference between the material upon this and upon the other hosts of the species.

ON POACEAE:

*Chaetochloa italica* (L.) Scribn., Iowa, \* *Halsted*; Michigan,  
*Wheeler*; Wisconsin, \* *Pammel*.

*Chaetochloa viridis* (L.) Scribn., Iowa, *Carver* 13, \* *Halsted*  
(N. Am. Fungi 1803a), \* *Hitchcock*, \* *Pammel* (Econ.

Fungi 64); Minnesota, \* *Pammel*; Nebraska, \* *Bates* (Fungi Columb. 1776); South Dakota, \* *Griffiths* (W. Am. Fungi 8); Wisconsin, *Trelease* (N. Am. Fungi 1803b).

TYPE LOCALITY: Selva, Italy, on *Chaetochloa verticillata* (L.) Scribn.

DISTRIBUTION: Vermont to South Dakota and Kansas. Also in Europe and Asia.

ICONES: Bot. Gaz. 11: pl. 8; Rabenh. Krypt. Fl. ed. 2. 1<sup>4</sup>: 438. f. 71; Fl. Nebr. 1: pl. 16. f. 4; Berlese, Icon. Fung. Phyc. pl. 9. f. 1; Bull. Soc. Bot. Ital. 1902: 169. f. 1-3; Bot. Mag. Tokyo 11: pl. 2.

## 2. SCLEROSPORA FARLOWII Griffiths, Bull. Torrey Club

34: 207. 1907

Infected areas on the leaf-sheaths, rarely on the leaf-blades, irregular in outline, usually elongate, brownish with a darker border, up to 10 mm. or more in length; conidiophores unknown; oöspores globose, 28-45  $\mu$ ; epispore slightly wrinkled, very opaque, reddish-brown, often appearing almost black.

Through the courtesy of Dr. Griffiths, material from the type locality was available for examination. This species is very distinct from *S. graminicola*, from which it differs in the slightly larger and more opaque oöspore with its lighter and smoother epispore. The disintegrating influence of the fungus upon the host is also absent in the present species, while in *S. graminicola* this is very pronounced.

ON POACEAE:

*Chloris elegans* H. B. K., Arizona, *Griffiths*.

TYPE LOCALITY: Cochise, Arizona, on *Chloris elegans* H. B. K.

DISTRIBUTION: Arizona and Sonora.

### Species inquirendae

Three additional species, of which the conidiophores are unknown, have been referred to this genus. The oöspores differ from those of *S. graminicola* in their lighter color, the thinner epispore, the difficulty of freeing them from the tissues of the host in which they are imbedded, and the failure of the affected leaves to liberate the oöspores by the rapid disintegration of the tissues

of the host. That these species are members of the present order is doubtful; and if they are, it is still more improbable that they are congeneric with the American species.

*S. Magnusiana* Sorokin, Rev. Myc. **11**: 143. 1889. On *Equisetum* sp., in the region of the southern Ural Mountains of Russia.

*S. macrospora* Sacc. Hedwigia **29**: 155. 1890. On *Alopecurus* sp. in Australia, and *Triticum vulgare* L., in Europe.

*S. Kriegeriana* Magnus, Verh. Deutsch. Naturf. **67**: 100. 1895. On *Phalaris arundinacea* L., in Europe.

#### 4. RHYSOTHECA gen. nov.

*Peronospora* § *Zoosporatoparac* de Bary, Ann. Sci. Nat. IV. **20**: 105. 1863.

Mycelium branching; haustoria simple; conidiophores erect, solitary or fasciculate, projecting through the stomata of the host, monopodially branched, the branches usually arising at right angles to the main axis, as do also the secondary branches, at least never appearing truly dichotomous, the ultimate branches apically obtuse; conidia globose to ovoid, hyaline, germinating directly by zoöspores; oöspores yellowish-brown, the episporium variously wrinkled, sometimes appearing somewhat reticulate; oögonium persistent but free from the oöspore. (Etymology, ῥυτός, wrinkled, θήκη, casket.)

Type species, *Peronospora viticola* (B. & C.) Casp.

To this genus belong the greater number of species which are usually referred to *Plasmopara*. That they are closely related to the preceding genera is evidenced by the habit of branching of the conidiophores and the germination of the conidia by zoöspores. *Plasmopara*, *sensu stricto*, has conidiophores with the ultimate branchlets apically obtuse as in the present genus, but with the general method of branching more nearly dichotomous than monopodial, and with the conidia germinating in a decidedly anomalous manner. The membrane breaks as in the present genus and the entire protoplasmic content escapes in a mass, forming a non-motile plasma from which a germ-tube is produced. That this is not the typical method of germination either for the *Rhysothecaceae* or the *Peronosporaceae* is evident, and unless the formation of a plasma be construed as the equivalent of zoöspore-formation the

genus cannot stand under the present tribe. That the method of germination is more nearly analogous to that of the *Peronosporae* is the view held by the present author. The genus *Rhysotheca* is therefore the most highly developed and the typical genus of the group of genera the conidia of which germinates by zoöspores, while *Plasmopara* stands in the same relation to *Peronospora* as does *Pseudoperonospora* to *Rhysotheca*.

#### Key to the species

- |  |                               |
|--|-------------------------------|
| Conidiophores low, averaging 300 $\mu$ or less, 2-3 times branched, the branches short.                | 1. <i>R. Geranii</i> .        |
| Conidiophores tall, averaging over 300 $\mu$ , 2-5, usually 4 or 5, times branched, the branches long. |                               |
| Ultimate branchlets elongate, cylindric.   |                               |
| Primary branches short, densely branched.  | 2. <i>R. Umbelliferarum</i> . |
| Primary branches elongate, lax.  |                               |
| Conidiophores 3-4 times branched.  |                               |
| Conidia small, about 15 $\times$ 17 $\mu$ .  | 3. <i>R. Epilobii</i> .       |
| Conidia large, about 27 $\times$ 35 $\mu$ .  | 4. <i>R. Helioearpi</i> .     |
| Conidiophores 4-5 times branched, very lax.  | 5. <i>R. obducens</i> .       |
| Ultimate branchlets more or less conic.  |                               |
| Ultimate branchlets broadly truncate.  |                               |
| Secondary branchlets very short.   | 6. <i>R. Halstedii</i> .      |
| Secondary branchlets lax.  |                               |
| Secondary branchlets sparingly branched.   |                               |
| Conidia about 12 $\times$ 15 $\mu$ .   | 7. <i>R. australis</i> .      |
| Conidia about 15 $\times$ 18 $\mu$ .   | 8. <i>R. illinoensis</i> .    |
| Secondary branchlets much branched; conidia about 14 $\times$ 22 $\mu$ .                               | 9. <i>R. viticola</i> .       |
| Ultimate branchlets narrowly truncate.   |                               |
| Conidia elliptic, about 15-20 $\mu$ long.  |                               |
| Conidiophores 2-4 times branched.  | 10. <i>R. Viburni</i> .       |
| Conidiophores 3-5 times branched.  | 11. <i>R. ribicola</i> .      |
| Conidia globose-elliptic, about 18-30 $\mu$ long.  | 12. <i>R. Gonolobi</i> .      |

#### 1. *Rhysotheca Geranii* (Peck)

*Peronospora Geranii* Peck, Rep. N. Y. State Mus. Nat. Hist. 28: 63. 1876.

*Peronospora nivea Geranii* Farlow; Ellis, N. Am. Fungi 218. 1879.

*Plasmopara Geranii* Berl. & De-Toni, in Sacc. Syll. Fung. 7: 248. 1888.

Hypophyllous; infected areas conspicuous, definite in outline, or often covering the entire leaf, white-downy; conidiophores fasciculate, monopodially 2-3 times branched, the branches short

and with the exception of the lowest rarely with well developed secondary branches,  $90-350 \times 9-12 \mu$ ; conidia obovoid, basally papillate, hyaline,  $18-25 \times 12-15 \mu$ ; oöspores surrounded by periplasm at maturity,  $25-35 \mu$ ; oögone persistent, wrinkled, yellowish-brown, as is also the epispore.

In Europe two other members of the order occur upon species of *Geranium*, but so far they have not been recorded from America nor has the present species been found abroad. The material issued under this name by Allescher and Schnabel in their *Fungi Bavarici 555* is *Plasmopara pusilla*, a much smaller species with almost simple conidiophores. Neither of these species is as large as *Peronospora conglomerata* Fuckel. The mycelium, according to Dr. Halsted,\* is perennial.

ON GERANIACEAE:

*Geranium carolinianum* L., Alabama, *Carver 150*, *Earle, Underwood*; Georgia, *Underwood 2242a*; Illinois, *Earle, Pammel, \*Seymour* (*Fungi Europ. 3176*, N. Am. *Fungi 1404*); Indiana, *Arthur, Underwood* (*Econ. Fungi A3*, Indiana Fl. 100); Mississippi, *Tracy*; Missouri, *Galloway, Pammel, Trelease*; New Jersey, *Ellis, Fairchild*; North Carolina, *Stevens*.

*Geranium dissectum* L., Mississippi, *Tracy* (*Fungi Columb. 405*, on "*Geranium carolinianum*").

*Geranium maculatum* L., District of Columbia, *Galloway 1357*; Indiana, *Olive*; Massachusetts, *Farlow* (N. Am. *Fungi 218*); New York, *Jackson 1154, Thom*; Ontario, *Dearness* (*Fungi Columb. 2048*); West Virginia, *Sheldon*; Wisconsin, *Davis, Pammel*.

*Geranium pusillum* L., Louisiana, *Langlois 942*; South Carolina, *Rolfs 1689*.

? *Geranium Richardsonii* Fisch. & Traut., Wyoming, *Pammel & Stanton*.

This species has also been reported from our limits on *Geranium Robertianum* L.

TYPE LOCALITY: North Greenbush, N. Y., on *Geranium maculatum* L.

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\* Bot. Gaz. 15: 321. 1890; 16: 338. 1891.

DISTRIBUTION: Massachusetts to Wyoming, Texas, and Georgia.

ICON: Berlese, Icon. Fung. Phyc. *pl.* 12.

## 2. *Rhysotheca Umbelliferarum* (Caspary)

*Botrytis nivea* Mart.; Unger, Exanth. 171. 1833. Not *B. nivea* Mart. 1817.

*Botrytis macrospora* Ditmar; Unger, Exanth. 173. 1833. Not *B. macrospora* Ditmar 1817.

*Peronospora macrocarpa* Rabenh. Herb. Viv. Myc. I. 1172. 1846. Not *P. macrocarpa* Corda 1842.

*Peronospora nivea* Unger, Bot. Zeit. 5: 314. 1847. Not *Botrytis nivea* Mart. 1817.

*Peronospora macrospora* Unger, Bot. Zeit. 5: 315. 1847. Not *Botrytis macrospora* Ditmar 1817.

*Peronospora Conii* Tul. Compt. Rend. Acad. Paris 38: 1103. 1854. (Nomen nudum.)

*Peronospora Umbelliferarum* Caspary, Monatsb. K. Preuss. Akad. Wiss. 1855: —(23). 1855.

*Plasmopara nivea* Schröt. in Cohn, Krypt. Fl. Schles. 3<sup>1</sup>: 237. 1886. Not *Botrytis nivea* Mart. 1817.

This species is included by Harkness and Moore in their *Pacific Coast Fungi* as having been collected in the region of San Rafael, Calif., on an undetermined species of *Umbelliferae*. Since then no new record of the species in North America has appeared. That the fungus is rather widely distributed on our continent is not impossible as it infests a wide range of Umbelliferous hosts, several of which are either wild or cultivated in various parts of America. A good illustration of the species is given by Berlese.\*

## 3. *Rhysotheca Epilobii* (Otth)

*Peronospora Epilobii* Otth, Bern. Mitth. 1868: 63. 1868.

*Plasmopara Epilobii* Schröt. in Cohn, Krypt. Fl. Schles. 3<sup>1</sup>: 238. 1886.

This species is rather widely distributed in Europe on various species of *Epilobium*, but so far has not been recorded from America. It is illustrated by Berlese.†

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\* Icon. Fung. Phyc. *pl.* 18.

† Icon. Fung. Phyc. *pl.* 14.



4. *Rhysotheca Heliocarpi* (Lagerh.)

*Plasmopara Heliocarpi* Lagerh. ; Pat. & Lagerh. Bull. Soc. Myc. France 8 : 123. 1892.

This species is known only from the type locality in Ecuador, where it occurs on the leaves of *Heliocarpus americanus* L. According to Dr. Rose \* the host name as given in the original description has been applied very loosely to various members of the Tiliaceous genus *Heliocarpus*, the species of which are widely distributed in tropical America. It is, therefore, not improbable that the fungus is of more than local occurrence and that it infests several hosts.

5. *Rhysotheca obducens* (Schröt.)

*Peronospora obducens* Schröt. Hedwigia 16 : 129. 1877.

*Plasmopara obducens* Schröt. in Cohn, Krypt. Fl. Schles. 3<sup>1</sup> : 238. 1886.

*Peronospora Impatientis* Ellis & Everh. Proc. Acad. Nat. Sci. Phila. 1891 : 86. 1891.

*Plasmopara Impatientis* Berlese, Icon. Fung. Phyc. 15. 1898.

Hypophyllous, usually on the cotyledons, the affected area irregular in outline, following the veins, or covering the entire surface of the leaf, white-cottony ; conidiophores fasciculate, 2-4 from a stoma, slender,  $300-500 \times 7-12 \mu$ , flexuously branched, the branches usually 4-5 times branched, ultimate branchlets about  $6-9 \mu$  long ; conidia broadly ellipsoid,  $12-14 \times 12-21 \mu$  ; oöspores light yellowish-brown,  $25-30 \mu$  ; episporer slightly wrinkled, or smooth ; oögone  $40-50 \mu$ .

In his monograph Berlese recognizes both *Plasmopara obducens* and *P. Impatientis* as valid species, due apparently to a misinterpretation of the original description of the latter species. In this the height of the unbranched portion only of the conidiophore is given. Otherwise the descriptions of the two species tally as closely as could be expected. Nor is this resemblance accidental, as the type of *Peronospora Impatientis* shows no perceptible points of difference from European material of *P. obducens* which was determined by Schröter himself.

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\* Cont. U. S. Nat. Herb. 8 : 315. 1905.

## ON BALSAMINACEAE :

*Impatiens aurea* Muhl., Alabama, Earle & Underwood ;  
Indiana, Arthur ; Iowa, Holway.

*Impatiens biflora* Walt., Connecticut, Underwood 2981 ;  
Delaware, Commons (type of *Peronospora Impatiensis*  
Ellis & Everh.) Jackson 1572 ; District of Columbia,  
Williams ; Indiana, Olive, Underwood, Wilson ; Mass-  
achusetts, Farlow, Halsted & Farlow (N. Am. Fungi  
207), Seymour (Econ. Fungi A7a, on "*Impatiens*  
sp."), Trelease ; Michigan, Merrow (Econ. Fungi A7b,  
on "*Impatiens* sp.") ; New York, Dudley & Under-  
wood ; Wisconsin, Davis, Pammel.

*Impatiens* sp., West Virginia, Sheldon.

TYPE LOCALITY : Rastatt, Germany, on *Impatiens Nolitangere* L.

DISTRIBUTION : Vermont to Minnesota, southward to Alabama.

Also in Europe.

ICON : Berlese, Icon. Fung. Phyc. pl. 15.

6. *Rhysotheca Halstedii* (Farl.)

*Peronospora Halstedii* Farl.; Ellis, N. Am. Fungi 209. 1879.  
(Hyponym); Proc. Am. Acad. 18:72. 1883.

*Peronospora Halstedii Ambrosiae* Ellis, N. Am. Fungi 210. 1879.  
(Hyponym.)

*Plasmopara Halstedii* Berl. & De-Toni, in Sacc. Syll. Fung. 7:242.  
1888.

Hypophyllous, on cotyledons and leaves, the affected area small, 1-3 mm., or extending over the entire leaf; conidiophores fasciculate, slender, 300-750  $\mu$ , 3-5 times branched, ultimate branchlets 8-15  $\mu$  long, verticillate below the apex of the branching axis which is frequently swollen and ganglion-like; conidia oval or elliptic, 18-30  $\times$  14-25  $\mu$ ; oöspores 30-32  $\mu$ ; epispore yellowish-brown, somewhat wrinkled.

This is the most unsatisfactory species of a difficult genus. The conidiophores are very variable, especially in the laxity of their branches and the development of the ganglion-like swelling from which the ultimate branchlets arise. Several forms are clearly distinguishable and are apparently valid species, but further search has invariably brought to light intermediate forms connecting the extremes with the typical form and with other forms. Until an

exhaustive study of a much greater quantity of material, both conidial and oösporic, is possible than is at present at hand, segregation of this species had best not be attempted. The extreme forms are found on *Eupatorium*, with but few branches with the ganglion-like structure, and on *Helianthus*, where the converse is true.

ON AMBROSIACEAE:

*Ambrosia artemisiaefolia* L., Iowa, *Arthur*, *Hitchcock*; Massachusetts, *Farlow* (N. Am. Fungi 210); Missouri, *Demetrio*; Wisconsin, *Pammel*.

*Ambrosia psilostachya* DC., Kansas, *Bartholomew* (Fungi Columb. 1563).

*Ambrosia trifida* L., Kansas, *Kellerman* (N. Am. Fungi 1403d); New York, *Jackson* 1129; Missouri, *Pammel*.

ON CARDUACEAE:

*Bidens cernua* L., Vermont, *Grout*.

*Bidens frondosa* L., Alabama, *Carver* 173; Illinois, ? *Pammel*; Indiana, *Wilson*; Iowa, *Arthur*, *Bessey*, *Hitchcock*; Kansas, *Swingle* 963; Michigan, *Merrow* (Econ. Fungi 298); Mississippi, *Tracy*; Nebraska, *Bates* (Fungi Columb. 2257); Ontario, *Dearnness*; Wisconsin, *Davis*, *Pammel*.

*Bidens laevis* (L.) B. S. P., Iowa, *Bessey*.

*Erechtites hieracifolia* (L.) Raf., Illinois, *Waite*; New Jersey, *Halsted* (Econ. Fungi 308 a); Massachusetts, coll. ign. (Econ. Fungi 308 b); Wisconsin, *Davis*.

*Erigeron annuus* (L.) Pers., Wisconsin, *Davis* (as *E. Philadelphicus* Willd.).

*Eupatorium ageratoides* L. f., Wisconsin, *Pammel*.

*Eupatorium purpureum* L., Iowa, *Bessey* (N. Am. Fungi 209); Michigan, *Merrow*.

*Gnaphalium spathulatum* Lam., Mississippi, *Earle*.

*Gnaphalium purpureum* L., Alabama, *Atkinson* (Econ. Fungi 314).

*Helianthus annuus* L., District of Columbia, *Scribner*; Indiana, *Arthur*, *Thomas*; Ohio, *Kellerman* (Ohio Fungi 68, on "*Vitis* sp.," later corrected); Ontario, *Dearnness* (Fungi Columb. 132); Wisconsin, *Pammel*.

*Helianthus divaricatus* L., Wisconsin, *Pammel*, *Trelease*.

- Helianthus doronicoides* Lam., Iowa, *Arthur*; Kansas, *Kellerman* (Fungi Europ. 3278, N. Am. Fungi 1403 c).  
*Helianthus grosseserratus* Martens, Iowa, *Hitchcock*, *Macbride*; Nebraska, *Sheldon*.  
*Helianthus hirsutus* Raf., Missouri, *Pammel*.  
*Helianthus Maximiliani* Schrad., Iowa, \* *Pammel*.  
*Helianthus occidentalis* Riddell, Wisconsin, *Pammel*.  
*Helianthus scaberrimus* Ell., Nebraska, *Bates* (Fungi Columb. 2139).  
*Helianthus strumosus* L., Minnesota, *Arthur*; Wisconsin, *Davis*.  
*Helianthus tuberosus* L., Pennsylvania, *Ellis* (N. Am. Fungi 1403 a); Wisconsin, *Farlow*, *Pammel*.  
*Helianthus* sp., New York, *Thom*; Missouri, *Galloway* (on "*Vernonia noveboracensis*"); Wisconsin, *Davis*.  
*Rudbeckia laciniata* L., Nebraska, *Sheldon*; North Dakota, *Seymour*; Wisconsin, *Davis*, *Pammel*.  
*Rudbeckia triloba* L., Illinois, *Hart*.  
*Silphium integrifolium* Michx., Kansas, *Kellerman* (Fungi Europ. 3279); Nebraska, *Sheldon*; Wisconsin, *Davis*, *Pammel*.  
*Silphium laciniatum* L., Iowa, *Arthur*.  
*Silphium perfoliatum* L., Iowa, *Bessey*; Minnesota, *Pammel*; Missouri, *Pammel*; Nebraska, *Sheldon*; Wisconsin, *Davis*, *Tracy*.  
*Silphium terebinthinaceum* Jacq., Illinois, *Pammel*; Wisconsin, *Davis*, *Pammel*, *Trelease* (N. Am. Fungi 1403 b).  
*Verbesina encelioides* (Cav.) A. Gray, New Mexico, *F. S. & E. S. Earle* 172.

The following additional hosts are reported from our limits : *Artemisia ludoviciana* Nutt., *Bidens comosa* (A. Gray) Wiegand, *B. connata* Muhl., *Centaurea* sp., *Helianthus trachaelifolius* Willd., *Iva xanthiifolia* (Fres.) Nutt., *Madia sativa* Molina, *Silphium trifoliatum* L., *Solidago canadensis* L., *S. Riddellii* Frank, *Vernonia Baldwinii* Torr., *V. noveboracensis* (L.) Michx., and *Xanthium canadensis* Mill. Of these two are somewhat doubtful, as it is quite probable that the record of *Iva* as a host refers to *Basidio-phora Kellermanii*, while a part of the material which served as the

basis for the citation of *Vernonia noveboracensis* as a host has been examined and instead of that species the host is some *Helianthus*, but as the leaves seen were all very young it is impossible to determine the species.

TYPE LOCALITY: Jamaica Plain, Massachusetts, on *Eupatorium purpureum* L.

DISTRIBUTION: Vermont to North Dakota, California, and Alabama. Also in Europe.

ICONES: Fl. Nebr. 1: pl. 16. f. 5; Berlese, Icon. Fung. Phyc. pl. 20.

#### 7. *Rhysotheca australis* (Speg.)

*Peronospora australis* Speg. Anal. Soc. Ci. Argent. 12: 36. 1881.

*Peronospora sicyicola* Trel.; Farlow, Bot. Gaz. 8: 331. 1883.

*Plasmopara australis* Swing. Trans. Kan. Acad. Sci. 11: 72. 1889.

Hypophyllous, the infected area amphigenously discolored, of variable size and shape, bounded by leaf-veins; conidiophores fasciculate, arising from the stomata of the host,  $500-650 \times 9-11 \mu$ , with 5-7 main branches, the branches monopodially 3-4 times branched, the ultimate branchlets  $10-14 \mu$  long; conidia widely ellipsoid,  $14-17 \times 10-13 \mu$ ; mature oöspores unknown.

This species is very distinct in habit as well as in other important characters from *Pseudoperonospora cubensis*, with which European mycologists have sometimes confused it. The mature oöspores are unknown, but the immature ones are described as almost hyaline and with a smooth epispore,  $30-40 \mu$ .\*

#### ON CUCURBITACEAE:

*Micrampelis lobata* (Michx.) A. Gray, Kansas, *Bartholomew* (Fungi Columb. 2334).

*Sicyos angulatus* L., Illinois, *Clinton*, *Pammel*, *Seymour* (Econ. Fungi 42, Fungi Europ. 3276b); Indiana, *Olive*, *Wilson*; Kansas, *Kellerman* (Fungi Europ. 3276a); Missouri, *Galloway*; Nebraska, *Bartholomew* (Fungi Columb. 2556); New York, *Jackson* 1150, *Thom*; Ohio, *Kellerman* (Ohio Fungi 147); Ontario, *Dearness*; Wisconsin, *Pammel*, *Trelease* (Fungi Gallici 3421, N. Am. Fungi 1416).

TYPE LOCALITY: Recoleta, Argentina, on *Cyclanthera Hystrix* Arn.

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\* Swingle, l. c.

DISTRIBUTION: Massachusetts to Ontario, Wisconsin, Kansas, and Ohio. Also in South America.

ICONES: Rep. Mass. State Agr. Exp. Sta. **8**: *pl. 2. f. 15, 16*; Rev. Myc. **22**: *pl. 203. f. 10, 11*; Berlese. Icon. Fung. Phyc. *pl. 16*.

#### 8. *Rhysotheca illinoensis* (Farl.)

*Peronospora illinoensis* Farl. Bot. Gaz. **8**: 332. 1883.

Hypophyllous; infected area irregular in outline, up to 10 mm., densely cottony, epiphyllous discoloration slight or none; conidiophores fasciculate, about  $500 \times 10 \mu$ , with 2-4 main branches which are 2-4 times laxly branched, the ultimate branchlets 10-12  $\mu$  long, subacute; conidia elliptic,  $15-18 \times 17-20 \mu$ ; oöspores unknown.

This species is known only from the collections of Professor Seymour at Camp Point and Quincy, Illinois. The inconspicuous habit of the fungus and the wide distribution of the host make it very probable that the species will be found to have a much wider range than now known. European botanists have excluded the species from the genus.\* Through the kindness of the authorities of the University of Illinois I have been permitted to examine material of the species. It is nearest to *R. australis*, but with much more irregularly branched and more flexuose conidiophores, which at first sight suggest those of *Pseudoperonospora Celtidis*.

ON URTICACEAE:

*Parietaria pennsylvanica* L., Illinois, Seymour 5302, 5354, 5355.

TYPE LOCALITY: Southern Illinois, on *Parietaria pennsylvanica* L.

DISTRIBUTION: Illinois.

#### 9. *Rhysotheca viticola* (B. & C.)

*Botrytis viticola* B. & C.; Berkeley, Jour. Hort. Soc. Lond. **6**: 289. 1851. (Hyponym.)

*Botrytis vitis-viticola* B. & C.; Taylor, Ann. Rep. U. S. Dep. Agr. **1871**: 110. 1872. (Hyponym.)

*Peronospora viticola* Caspary, Monatsb. K. Preuss. Akad. Wiss. **1855**: 331. 1855. (Hyponym); de Bary, Ann. Sci. Nat. IV. **20**: 125. 1863.

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\* A. Fischer; Rabenh. Krypt. Fl. ed. 2. **4**<sup>1</sup>: 485. 1892. — Berlese, Icon. Fung. Phyc. **41**. 1898.

*Plasmopara viticola* Berl. & De-Toni, in Sacc. Syll. Fung. 7: 338. 1888.

Hypophyllous, caulicolous, or on young fruits, covering the host with a white downy growth, or causing a brown rot of the fruit without producing aerial hyphae; conidiophores fasciculate,  $250-850 \times 5-8 \mu$ , 4-5 times branched, the ultimate branchlets about  $8 \mu$  long; conidia elliptic-ovate, very variable in size,  $9-12 \times 12-30 \mu$ ; oöspores  $30-35 \mu$ ; epispore brown, wrinkled, or almost smooth: oögone thin-walled, hyaline or light yellowish-brown.

This is one of the worst fungous pests of the vineyard. It was first collected in the United States by Schweinitz in 1834, and referred to *Botrytis cana* Link. Later Ravenel, Curtiss, and others sent material from South Carolina and New England to Berkeley and de Bary. The first published account of the species which has come to our notice is by Berkeley, who, in publishing a translation of one of Léveillé's papers upon the *Oidium* of the vine, remarks that "a true *Botrytis* of the same section with *Botrytis infestans*\* but far more beautiful, and highly developed, occurs in South Carolina on vine leaves. I have not, however, heard that it is injurious. My specimens, which were gathered by Mr. Ravenel, and have been named *B. viticola* Berk. and Curt., occurred on *Vitis aestivalis*, and, I believe, on some other species."†

In more recent years mycologists of this and other countries have experienced a decided change of opinion as to the injurious character of the disease. Berlese‡ estimates that 75 per cent. of the crop is destroyed in the northern states by this disease. That this is as extreme a view as the one previously quoted is not improbable, yet that great injury, especially to some varieties, is due to this fungus is certain. The most destructive form is that which occurs on the fruits as a brown rot.

#### ON VITACEAE:

*Parthenocissus quinquefolia* (L.) Planch., Alabama, *Underwood*; Minnesota, *Farlow* (N. Am. Fungi 1402, on "*Ampelopsis quinquefolia*"), *Seymour*; New York *Jackson*, 1124.

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\* *Phytophthora infestans* (Mont.) de Bary.

† Jour. Hort. Soc. London 6: 289, note. 1851.

‡ Riv. Pat. Veg. 9: 102. 1902.

*Parthenocissus tricuspidata* (Sieb. & Zucc.) Planch., New Jersey, *Halsted* (N. Am. Fungi 2427 b, on "*Ampelopsis Ritchii*," error for the horticultural name *A. Veitchii*).

*Vitis aestivalis* Michx., Indiana, *Arthur*; Massachusetts, *Grout*; South Carolina, *Ravenel* (Fungi Am. Exs. 61; Myc. Univ. 617, on "*V. vinifera*" but subsequently corrected; Fungi Carol. 5: 90).

*Vitis bicolor* Le Conte, New York, *Long*.

*Vitis californica* Benth., California, *Harkness* (N. Am. Fungi 2247a).

*Vitis cinerea* Engelm., Illinois, *Pammel*.

*Vitis cordifolia* Michx., Indiana, *Olive*; Illinois, *Earle*, *Hart*, *Waite*; Missouri, *Jaeger*, *Trelease*; New York, *Underwood*; Ohio, *Aiken* (Phyc. Prot. 122); Wisconsin, *Pammel*.

*Vitis labrusca* L., Connecticut, *Sheldon*; District of Columbia, *Scribner*, *Williams*; Iowa, *Buchanan*, *Griffin*, *Pammel*, *Stewart*, *Rolfs*, *Macbride*; Kansas, *Kellerman* (Fungi Par. Plant. Colt. 102, on "*Vitis Concord*"; Roum. Fungi Sel. Exs. 5517, on "*Vitis* cultive var. (*Concord*)"); Massachusetts, *Farlow* (N. Am. Fungi 208, on "*Vitis* cult."), *Seymour* (Econ. Fungi 3, on "*Vitis* sp. cult."), *Underwood*; New York, *Blodgett*; Ohio, *Kellerman* (Ohio Fungi 169a, on "*Vitis* sp. cult."); Pennsylvania, *Ellis*; Wisconsin, *Henry*, *Pammel*, *Trelease*, *Underwood*.

*Vitis rotundifolia* Michx., Michigan, *Merrow* (Econ. Fungi 3a, on "*Vitis* sp.>").

*Vitis vulpina* L., Iowa, *Arthur*, *Hitchcock*; Kansas, *Bartholomew* (Fungi Columb. 2345); New York, *Jackson* 1120, *Stevens* (Fungi Columb. 545, on "*Vitis riparia*"); Ohio, *Kellerman* (Ohio Fungi 169b); West Virginia, *Sheldon*; Wisconsin, *Clinton*, *Pammel*.

An additional host, *Vitis vinifera* L., is reported from North America.

TYPE LOCALITY: South Carolina, on *Vitis aestivalis* Michx.

DISTRIBUTION: Coextensive with the grape (*Vitis* spp.) throughout the world.



ICONES: Rep. U. S. Dep. Agr. 1871: *pl.* 4; Bull. Bussey Inst. 1: *pl.* 2. *f.* 1, *pl.* 3. *f.* 2-8; Bull. Ill. Lab. Nat. Hist, 1<sup>1</sup>: *Par. Fungi pl.* 2. *f.* 6, 7; Rep. U. S. Dep. Agr. 1886: *Mycol. pl.* 1; Berlese, Icon. Fung. Phyc. *pl.* 17, 18.

#### 10. *Rhysotheca Viburni* (Peck)

*Plasmopara Viburni* Peck, Rep. N. Y. State Mus. Nat. Hist. 43: 74. 1890.

Hypophyllous, affected areas irregular in outline, 3-10 mm. in diam., marginal or following the larger veins, sparingly white-downy, epiphyllous discoloration none to dark reddish-brown or chocolate-colored; conidiophores fasciculate, sparingly 2-3, rarely 4 times branched, 300-600  $\times$  6-8  $\mu$ , ultimate branchlets 6-8  $\mu$ ; conidia broadly elliptic, rarely globose, 15-30  $\times$  12-15  $\mu$ , or larger; oöspores unknown.

The present species and the two following ones form a distinct group, and are very closely related; all of them are poorly understood and by no means common in collections. The present species is especially close to *R. ribicola*, from which it differs in its taller conidiophores, its sparser covering and more pronounced discoloration of the host.

#### ON CAPRIFOLIACEAE:

*Viburnum acerifolium* L., District of Columbia, *Waite*; West Virginia, *Waite*.

*Viburnum dentatum* L., New York, *Peck* (cotype), *Thom*.

*Viburnum nudum* L., Alabama, *Earle* (Phyc. Prot. 81).

*Viburnum Opulus* L., Maryland, *Fairchild*.

*Viburnum pubescens* (Ait.) Pursh, West Virginia, *Waite* 721.

TYPE LOCALITY: Baiting Hollow Station, Long Island, N. Y., on *Viburnum dentatum* L.

DISTRIBUTION: Central New York to Alabama.

#### 11. *Rhysotheca ribicola* (Schröt.)

*Peronospora ribicola* Schröt., Jahrb. Schles. Ges. Vaterl. Kult. 1883: 139. 1883.

*Plasmopara ribicola* Schröt. in Cohn, Krypt. Fl. Schles. 3<sup>1</sup>: 238. 1886.

Hypophyllous, infected area usually near the main veins, irregular in outline, up to 15 mm., loosely downy, epiphyllous dis-

coloration light and usually not pronounced; conidiophores fasciculate,  $200-400 \times 7-9 \mu$ , 3-5 times branched, ultimate branchlets  $4-8 \mu$  long; conidia elliptic to globose-elliptic,  $14-22 \times 10-14 \mu$ ; oöspores unknown.

This is one of the rarest species of the genus. It is distinguishable from the preceding species by its more conspicuous habit of growth, the smaller conidiophores, and the less pronounced discoloration of the host.

ON GROSSULARIACEAE:

*Ribes albinervum* Michx., Wisconsin, Davis (Fungi Columb. 1753, on "*Ribes rubrum subglandulosum* Maxim.").

*Ribes divaricatum* Dougl., Washington, Piper 2957.

*Ribes hirtellum* Michx., Wisconsin, Davis (on "*Ribes oxycanthoides* L.").

*Ribes prostratum* L'Her., Wisconsin, Davis.

*Ribes rotundifolium* Michx., West Virginia, Sheldon.

TYPE LOCALITY, Liegnitz, Germany, on *Ribes rubrum* L.

DISTRIBUTION: West Virginia to Washington. Also in Europe.

## 12. *Rhysotheca Gonolobi* (Lagerh.)

*Peronospora Gonolobi* Lagerh. Jour. Myc. 7: 49. 1891.

*Plasmopara Gonolobi* Swingle, Jour. Myc. 7: 119. 1892.

*Plasmopara Vincetoxici* Ellis & Everh. Jour. Myc. 8: 70. 1902.

Hypophyllous, infected area about 2-5 mm. bounded by the veins, rather well covered with conidiophores, epiphyllous discoloration light-brown; conidiophores fasciculate,  $300-600 \times 8-10 \mu$ , 4-6 times branched, ultimate branchlets  $6-10 \mu$  long; conidia globose-elliptic, rarely elliptic,  $16-25 \times 13-24 \mu$ , or even larger; "oöspores globose, brown, about  $20 \mu$  diam."

The type material of *Peronospora Gonolobi* was collected by Dr. J. H. Mellichamp and sent to Dr. Farlow, who distributed the collection for *Puccinia Gonolobi* Rav., the predominating parasite on the material, and so far as some of the specimens are concerned the only one. Among these latter is the one in the Ellis herbarium. It was, however, possible to determine positively the species of the host which was cited by Lagerheim as *Gonolobus* sp. but which is in reality *Vincetoxicum hirsutum*. The host of *Plasmopara Vincetoxici* is also the same species. This discovery led to the conclusion that the two species were the same, a conclusion which

has since been borne out by an examination of authentic material of the earlier species. The present species is easily distinguished from either of the two preceding ones by its larger conidia and more complexly branched conidiophores.

ON ASCLEPIADACEAE :

*Vincetoxicum hirsutum* (Michx.) Britton, Alabama, Carver 932. (Type of *Plasmopara Vincetoxici*.)

*Vincetoxicum suberosum* (L.) Britton, Florida, McCulloch.

An additional host, *V. gonocarpus* Walt., is also recorded.

TYPE LOCALITY : Blufton, South Carolina, on *Gonolobus* sp. (= *Vincetoxicum hirsutum* (Michx.) Britton).

DISTRIBUTION : Maryland to Florida and Mississippi.

5. PSEUDOPERONOSPORA Rostew. Ann. Inst. Agron.

Moscou 9 : 47. Ja 1903. — Flora 92 : 422. O 1903

*Plasmopara* § *Peronoplasmopara* Berl. Riv. Pat. Veg. 9 : 122. 1901.

*Peronoplasmopara* Clinton, Rep. Conn. State Agr. Exp. Sta. 29 : 234. 1905.

Mycelium intracellular, branching, haustoria small, usually simple ; conidiophores pseudo-monopodially branched, the primary branches arising, as a rule, at acute angles, the ultimate branchlets acute ; conidia typically colored, rarely hyaline, elliptic in outline, conspicuously papillate both apically and basally ; oöspores thin-walled, smooth or roughened ; oögone thin-walled.

Type species, *Peronospora cubensis* B. & C.

The present genus is the most anomalous of the tribe, combining as it does certain characteristics of the present and succeeding tribes. The conidia germinate, as in all species of the *Rysotheceae*, by zoöspores, while the colored conidia suggest a close relationship with *Peronospora*. This is further augmented by the apically acute conidiophores, the method of branching of which is intermediate between the typical method of the two tribes in question.

The close relationship of the two species to each other and their problematical taxonomic position was pointed out by Waite at the time he described the second one.\* He, however, allowed them to remain in the genus *Peronospora*. The next step was

\* Jour. Myc. 7 : 105. 1892.

taken by Berlese, who formed for them a subgenus under the old genus *Plasmopara*, which he characterized as having the conidiophores of *Peronospora* and the conidia of *Plasmopara*, i. e. *Rhysotheca* of the present treatment of the group. The final step was taken by Rostewzew who made an extensive study of *P. cubensis*, the results of which appeared in an elaborate paper which was published first in Russian and later in German. He concluded that this species represented a distinct genus intermediate between *Peronospora* and *Plasmopara*, *sensu* Schröter. He called the genus *Pseudoperonospora*, choosing this name, as he tells us, rather than *Pseudoplasmopara* as *Peronospora* antedates *Plasmopara*. Later Dr. Clinton made an extended study of the species in America, publishing an admirable paper upon his researches. Unfortunately, at least from a nomenclatural standpoint, he rejected the earlier generic name in favor of Berlese's subgeneric name, and still more unfortunately he has been followed in this by other American mycologists. The name proposed by Rostewzew has more than two years priority over the elevation of Berlese's subgenus to generic rank, and is therefore the rightful name of the genus.

#### Key to the species

Conidiophores 3-4 times branched.

1. *P. cubensis*.

Conidiophores 4-5 times branched.

2. *P. Celtidis*.

#### 1. PSEUDOPERONOSPORA CUBENSIS (B. & C.) Rostew.

Ann. Inst. Agron. Moscou **9**: 47. Ja 1903. —

Flora **92**: 422. O 1903

*Peronospora cubensis* B. & C. Jour. Linn. Soc. Bot. **10**: 363. 1868.

*Plasmopara cubensis* Humphrey, Rep. Mass. State Agr. Exp. Sta. **8**: 212. 1891.

*Peronoplasmopara cubensis* Clinton, Rep. Conn. Agr. Exp. Sta. **1904**: 335. 1905.

Hypophyllous, or rarely amphigenous; discoloration of the host yellowish, rather definite in outline, affected area apparently unoccupied or with a sparse marginal growth; conidiophores 1-2, rarely more, from a stoma, 180-400  $\times$  5-9  $\mu$ , 3-4, rarely 2-5, times branched, the ultimate branchlets recurved, apically acute, 5-20  $\mu$  long; conidia gray, brownish or smoky, ovoid to ellipsoid, papil-

late,  $20-40 \times 14-25 \mu$ ; oöspores spherical, yellowish, watery-papillate,  $30-43 \mu$ , maturing in the decaying leaves.

This is one of the most important pests of the truck farmer. Its adaptability to almost any cultivated species of *Cucurbitaceae* and the comparative immunity of the native species, especially in the more northern states, makes it a pest which is most destructive in regions where Cucurbitaceous vegetables are cultivated in commercial quantities. Its favorite hosts appear to be the cucumber and melon. It has been suggested that the fungus spreads from south to north each season, and in proof of this theory are cited the perennial character of the mycelium in Florida and the records of the distribution of the pest in the southern and eastern states in recent years.\* It has also been suggested that hot-house culture of the hosts assists in scattering the disease, at least in the immediate vicinity. It is not impossible that both these factors enter into the distribution of the fungus, while the researches of Rostewzew, who found the immature oöspores in the partially decayed leaves of infested vines, tend to establish the probability that oöspore-production also plays a most important part in the persistency of the pest in infested areas. By the first two means suggested, the distribution of the fungus would of necessity be confined to those regions which could be reached by summer migration and in which hot-house cucurbits were produced. The third method of passing the winter, in addition to the first two, accounts for the occurrence and persistence of the disease in places which, according to the two preceding theories, should be immune from the pest. The problem presented is one of great scientific interest and of a not inconsiderable financial importance to certain sections of the country.

ON CUCURBITACEAE:

*Bryonopsis lacunosa erythrocarpa* Naud., Ohio, Selby.

*Citrullus vulgaris* Schrad., Louisiana, Langlois 1122.

*Coccinia indica* Wright & Arn., Ohio, Selby.

*Cucumis angulatus* Forsk., Ohio, Selby.

*Cucumis Melo* L., Ohio, Selby.

*Cucumis odoratissimus* Moench, Ohio, Selby.

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\* Bull. S. Car. Agr. Exp. Sta. 116: 7. 1905.

*Cucumis sativus* L., Florida, *Hume* 24; Massachusetts, *Humphrey*; New Jersey, *Halsted* (N. Am. Fungi 2426a; Econ. Fungi 41), *Stevens*; Maryland, *Dorsett*; Ohio, *Selby* (Phyc. Prot. 119); West Virginia, *Sheldon*.  
? *Cucurbita maxima* Duch., New Jersey, *Halsted* (N. Am. Fungi 2426b).

*Cucurbita ovifera* L., Ohio, *Duvel*.

*Cucurbita Pepo* L., Ohio, *Duvel*.

*Lagenaria vulgaris* Ser., Ohio, *Duvel*.

*Micrampelis lobata* (Michx.) Greene, Ohio, *Selby*.

*Momordica balsamina* L., Iowa, *Arthur*.

*Mukia scabrella* Arn., Ohio, *Duvel*.

The following additional hosts are reported from within our limits: *Cucumis Anguria* L., *Melothria scabra* Naud., *Momordica charantia* L., *Sicyos angulatus* L., *Trichosanthes colubrina* Jacq.

TYPE LOCALITY: Cuba, on some unidentified species of *Cucurbitaceae*.

DISTRIBUTION: New Hampshire to Minnesota, Texas, Florida, and Cuba. Also in South America, Europe, Asia, and Africa.

ICONES: Riv. Pat. Veg. 9: 125. f. 21; Rep. Mass. State Agr. Exp. Sta. 8: pl. 2. f. 11-14; Bull. Ohio Agr. Exp. Sta. 89: pl. 1; Rep. Fla. Agr. Exp. Sta. 1899-00: pl. 1; Rev. Myc. 22: pl. 203. f. 7-9; Rep. Conn. Agr. Exp. Sta. 1904: pl. 31.

## 2. *Pseudoperonospora Celtidis* (Waite)

*Peronospora Celtidis* Waite, Jour. Myc. 7: 105. 1892.

*Plasmopara Celtidis* Berlese, Icon. Fung. Phyc. 16. 1898.

*Peronoplasmopara Celtidis* Clinton, Rep. Conn. Agr. Exp. Sta. 1904: 334. 1905.

Hypophyllous, infected areas brownish, limited by the veins, from less than 1 mm. up to covering a large portion of the leaf; epiphyllous discoloration purple with a more or less pronounced yellowish margin; conidiophores scattered,  $200-320 \times 6-8 \mu$ , 4-5 times branched, the ultimate branchlets straight or slightly recurved, about  $5-8 \mu$  long; conidia elliptic,  $12-26 \times 20-40 \mu$ , smoky or somewhat purplish; oöspores in the leaves,  $26-45 \mu$ ; epispore thin, yellowish-brown, irregularly thickened; oögone persistent, thin-walled, smooth.

This species is remarkable as the only member of the order

which infests a tree, although a few species occur on shrubs. Perhaps this unusual habitat accounts for the rarity of the species in herbaria.

ON ULMACEAE :

*Celtis occidentalis* L., District of Columbia,\* *Waite* 556, 557.

TYPE LOCALITY: Washington D. C., on *Celtis occidentalis* L.

DISTRIBUTION: Maryland and District of Columbia.

ICON: Jour. Myc. 7: *pl.* 17. *f.* 1-16.

NEW YORK BOTANICAL GARDEN.